

## FORMULATING QUESTIONS FOR SCIENTIFIC RESEARCH

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The examples given below are mainly related to environmental issues within the context of current and future policy needs in Wales. The same question-setting principles will also apply in the social and economic research fields.

### Type of Question

We should pose questions that can inform policy and be addressed through scientific research in an appropriate time period and at reasonable cost. This may include questions for which a body of relevant research may already exist, but which has not yet been synthesised or reviewed for corroborating findings. We are looking for the kinds of questions, that when researched can form a reliable “evidence-base” for policy.

Questions should be capable of a factual answer. For example:

NOT – “Should we provide grants for home insulation”

BUT – “By how much would the provision of grants for home insulation reduce the consumption of fossil energy?”

The questions should be those that a team of researchers might reasonably be expected to answer within the relevant policy cycle. For this purpose it is best to avoid ‘major issues and possible solutions’ kinds of questions. Examples of such unsuitable questions for short-term scientific study would be:

What are the likely impacts of climate change on land use in Wales?

What is the best way to mitigate against sea-level rise?

Is it feasible to restore our floodplain woodlands?

These are important questions but science can only provide part of the answer. These questions need ‘un-packing’ to produce a number of more specific questions, practically answerable by scientific study.

### Form of Question

1. The question should have a clear subject of concern:

Examples - air quality, water quality, habitat quality, species abundance, carbon sequestration, public health, physical and mental well-being.

2. The question should ask about the impact of a human activity or the effectiveness of an intervention which relates to the state of the subject:

Examples of impacts and interventions – construction, pollution, business management, land use, conservation policy.

3. The question should give a clear indication of what would be measured to indicate a change in the state of the subject:

Example - change in abundance of subject; change in chemical composition; change in an indicator of well-being.

A number of different types of question were recognised in: “The identification of 100 ecological questions of high policy relevance in the UK” (Sutherland et al, *Journal of Applied Ecology* 43(4):7–627, August 2006).

1. Questions of basic understanding (understanding system function and improving predictive power)
2. Questions about appropriate methodology (how do we measure x?)
3. Questions about impacts (e.g. impacts of human actions on biodiversity or ecosystems)
4. Questions about effectiveness of interventions (does a management or policy action work?)
5. Questions about optimization of interventions (can an accepted intervention be more effective?)

Categories 1-2 lack precision, can be very open-ended and although they present significant challenges to science, may not provide a clear focus for research. They need unpacking, e.g:

Category. 1: What is the role of biodiversity in maintaining specific ecosystem functions (e.g. biogeochemical cycles)?

Category. 2: How can we measure natural capital (renewable and non-renewable resources) and integrate such a measure into gross domestic product (GDP)?

We recommend that you try and provide focus for such questions, e.g:

Category 1: How long does the seabed take to recover from a disturbance such as dredging, wind-farm construction, oil and gas extraction etc?

Category 2: What are the relative merits of different indices of habitat connectivity? Which of them best predicts conservation value?

Categories 3-5 can have a more precise structure in that they will have a subject, an intervention and a measurable outcome. Thus the question suggests the form of experiment that is needed to address it:

**Examples of human impact questions:**

What impact do wind-farm installations have on local bird population abundance?

(Subject: birds; human action: wind farm installation; Measurable outcome: bird population abundance)

Category 3. What are the direct (catch) and indirect (food supplementation by discards, prey depletion) impacts of commercial fishing on cetaceans and seabirds?

(Subject: Cetaceans and seabirds; Intervention: commercial fishing; Measurable Outcome: change in population sizes)

**Examples of effectiveness of intervention questions:**

Do engineered in-stream devices result in enhanced populations of trout and salmon?

(Subject: trout and salmon; Intervention: Construction of in-stream devices (fish-passes, step-weirs etc); Measurable outcome (desired): increase in numbers of trout and salmon)

Which approach to the removal of plantations on ancient woodland sites (e.g. clear-felling and sequential removal) yields the greatest biodiversity benefit?

(Subject: ancient woodland biodiversity; Intervention: plantation removal techniques; Measurable outcome: change in biodiversity).

How large should Marine Protected Areas be, and where should they be located to protect biodiversity and enhance surrounding fisheries?

(Subject: Fish/fisheries; Intervention: MPAs; Measurable outcome: change in fish populations).

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